Observing of spatial quantum correlations induced by multiple scattering of light

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We investigate the transport of non-classical light through multiple scattering random media. So far almost all experiments in the multidisciplinary field multiple light scattering have concentrated on the transport of light intensity. In recent years the quantum nature of multiple scattered light has been considered by studying the photon fluctuations of the light [1]. It was predicted that fluctuations below the classical limit can survive multiple scattering and novel spatial quantum correlations can be induced [2]. In accordance with the Heisenberg uncertainty principle, photon fluctuations smaller than the classical limit can only be generated with non-classical light sources. Using squeezed light we performed the first experimental demonstration that non-classical fluctuations survive multiple scattering of light. The experiments are in excellent agreement with theory. Moreover we demonstrate experimentally that multiple scattering induces novel spatial quantum correlations, cf. Fig. 1.

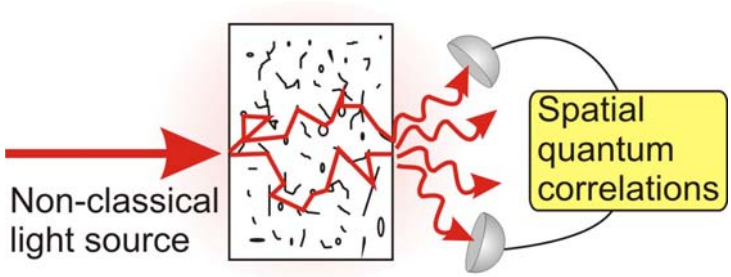

Fig 1. Illustration of multiple scattering process leading to spatial quantum correlations. A non-classical light source illuminates a medium consisting of a random distribution of scatterers. The incoming light is split into a multitude of different trajectories that perform a random walk through the medium. The number of photons exiting the medium in a specific direction can be anti-correlated with the number of photons in another direction, and this correlation depends on the quantum state of light illuminating the medium.

References

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2. P. Lodahl, A. P. Mosk, and A. Lagendijk “Spatial quantum correlations in multiple scattered light”. Phys. Rev. Lett. 95, 173901--173904 (2005).